Volume 25 January 1939 *Number 1*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Lubrication in the Field of Contracting

PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

SPEEDS ROAD JOB TO BEAT *Jack Frost*

PLANT *of Koepke Construction Company, Appleton, Wisconsin, set up along Highway 22.*

TO SERVICE *the 9 trucks and other engines on this job, 750 gallons of* Fire-Chief *had to be hauled 28 miles, and arrive before 5 A.M. each day.*

MAP OF WISCONSIN *showing Green Bay section of Lake Michigan where Texaco helped contractor to beat early freeze-up.*

ROCK DRILL BOOKLET. *Texaco's latest contribution to the care and lubrication of rock drills. 36 pages. Write for your copy.*

UP IN THE GREEN BAY COUNTRY, Old Man Winter gets on the job in early fall.

With 8 miles of road building ahead of them, the Koepke Construction Company just had to keep the job going . . . or get frozen in for the winter.

They put it up to Texaco to keep their equipment going, and Texaco came through.

All cranes, shovels, pavers, trucks, tractors, crushers, screening plants were lubricated with Texaco Marfak and other Texaco Lubricants. In fact, the job was Texaco fueled and lubricated 100%.

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LUBRICATION

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The Texas Company, 135 East 42nd Street, New York City

Vol. XXV January, 1939 No. 1

Change of Address: In reporting change of address kindly give both old and new addresses.

Lubrication in the Field of Contracting

TO understand the theories of lubrication and to appreciate those factors which determine the relative lubricating value of any lubricant is commendable; to be able to put this knowledge into practice signifies that machine requirements are quite as fully understood. Today, the operator of contracting machinery is prone to become such an individual; he has graduated from the status of a lever-pusher, appreciative of the financial responsibility imposed upon him. His success is measured by yardage of materials handled, by ability to meet contract dates, and by the cost of upkeep or maintenance of his equipment.

This latter is definitely associated with the theory of lubrication; the more effectively it is put into practice, the better the protection of the working elements. In applying any theory, however, one must consider the practical requirements — in the contracting field, the operating conditions. In other words, certain grades of lubricants should function satisfactorily on certain mechanisms. The operator knows, however, that this premise is based on laboratory procedure, or controlled testing. Subjected to the rains of the Ohio or Mississippi Valleys, the sleet of the Lakes Region, or the dust of the wheat belt, such lubricants might tell an entirely different story.

Power is the basis of successful operation. The requirements imposed upon the power plant in the modern shovel, drag-line or scraper are intensive. When we used to regard a cubic yard as adequate capacity for the bucket or scoop, wet steam around 100 pounds pressure sufficed to run the engines which operated the shovel mechanisms. Today, however, the contractor takes his shovel capacity far more seriously. Yardage is the basis of many of his bids, but yardage can only be moved—be it earth, stone or metallic materials—by a rugged power plant of sufficient capacity to meet shock loads.

So higher steam pressures and better insulation against condensation were adopted. This called for more durable boiler construction. Then the Diesel and electric drives came into the picture; the former being especially adaptable to the self-propelled unit, the latter to the railway-type shovel and hoist.

These mechanisms required more careful attention to lubrication. Their application brought home more forcibly the fact that highway construction machinery will very frequently be subjected to decidedly intensive conditions which may tend to impair lubrication to a marked extent. Wide temperature fluctuations, the presence of a considerable amount of dust and dirt, and the possibility of moisture affecting the lubricant must not be overlooked.

So the operator should not be content with lubricants capable of functioning satisfactorily on more protected machinery. He must take into account the exposed nature of his shovels, draglines, concrete mixers, etc., and the extent to which the construction of their moving parts may be conducive to contamination of the

lubricants. Water is especially detrimental. Wherever it is present in any appreciable amount it will tend to wash off certain types of lubricating films, if these latter have not been developed by lubricants especially refined and prepared to resist this washing action.

Abrasives Are Serious

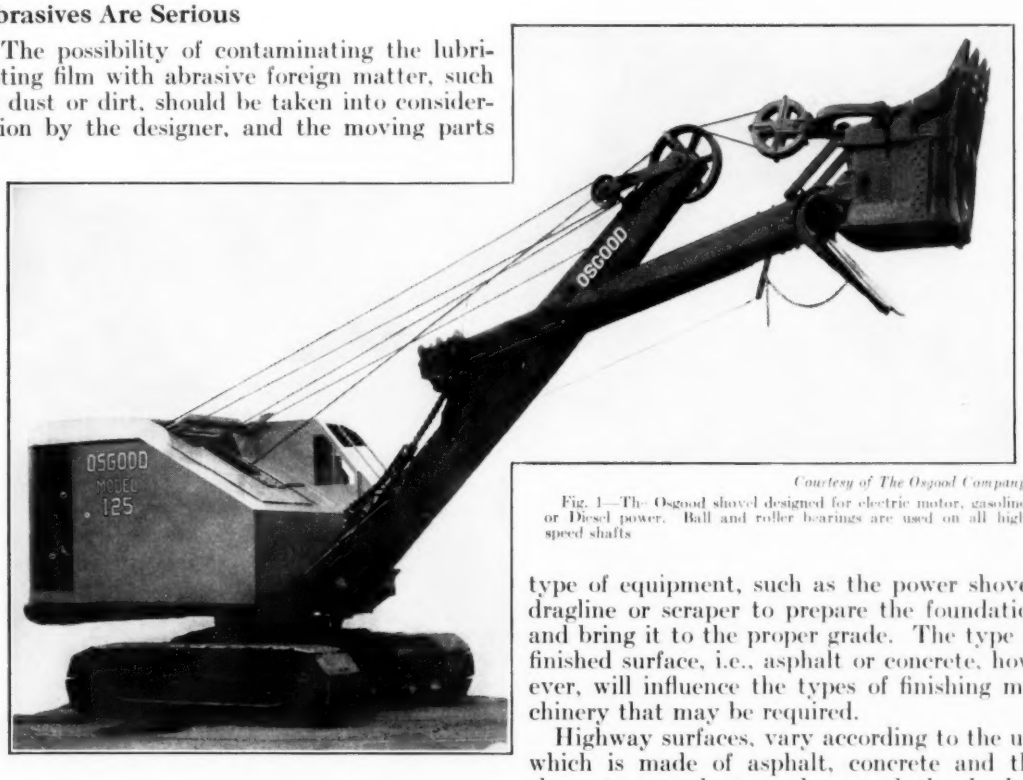
The possibility of contaminating the lubricating film with abrasive foreign matter, such as dust or dirt, should be taken into consideration by the designer, and the moving parts designed as nearly as possible to prevent entry of same. Wherever a bearing or gear set is so inadequately constructed as to permit the entry of dust or dirt, it will be virtually impossible for any lubricant to prevent the development of wear.

In bearing service some protection can be attained by using a heavy grease which will develop a protective collar at the exterior surface of the bearing as the lubricant is injected or works its way through the bearing clearance. Naturally an oil or a light grease would not develop such protection to the same degree and there would be too much tendency towards dripping from the bearings.

In the case of gears, chains or wire rope, however, but little use of the dust or dirt-tight housing is made. This is, of course, impracticable, due to the very nature of the construction of the machinery and parts involved. Here the lubricant must be relied upon to protect the moving parts as completely as possible against the abrasive effects of foreign matter.

THE MACHINERY REQUIRED

In the handling of contracting machinery one must consider the preliminary work with bulk materials, and the type of finish to be applied in highway service. The preparation of the roadbed will require virtually the same type of equipment, such as the power shovel, dragline or scraper to prepare the foundation and bring it to the proper grade. The type of finished surface, i.e., asphalt or concrete, however, will influence the types of finishing machinery that may be required.



Courtesy of The Osgood Company

Fig. 1—The Osgood shovel designed for electric motor, gasoline or Diesel power. Ball and roller bearings are used on all high speed shafts

Highway surfaces, vary according to the use which is made of asphalt, concrete and the elementary products, such as crushed or broken stone, sand or paving blocks. We will not presume to discuss the relative merits of these materials; our problem is to investigate the lubricating requirements of the machinery employed in their application.

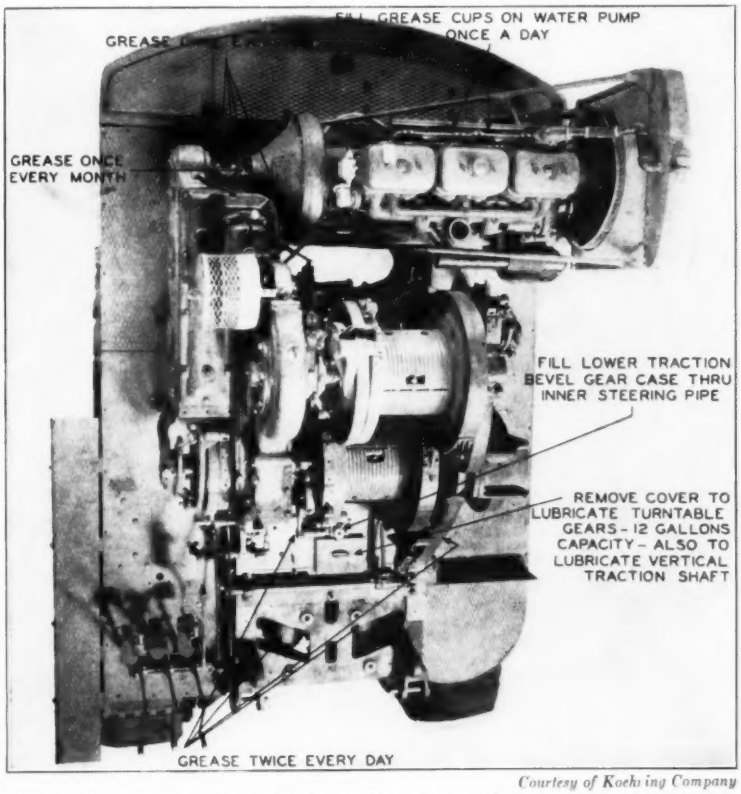
The Power Plant

The reciprocating steam engine used to be most extensively used as the means of driving the various elements on the power shovel, dragline or scraper. More recently, however, the internal combustion engine of the gasoline or Diesel type has been widely adopted. It is furthermore interesting to note that compressed air is being employed in place of steam as a means of driving certain types of swing and crowd engines in shovel and dragline service.

The electric motor has also been adapted to such machinery, especially in stationary installations, such as are involved in mining or stone quarry service and certain types of railway maintenance work.

In studying the lubrication of construction

machinery, it is essential to consider the design of the machine, with due thought for the means of lubrication and the operating conditions. It must be realized that air, steam, gasoline or fuel oil are quite different in regard to their reaction or effects upon certain types of lubricating oils.



Courtesy of Koehring Company

Fig. 2—Top view of a Koehring shovel power plant showing points to be lubricated and instructions for same.

It is hardly necessary to bring this to the attention of the operator. It is, however, advisable to impress him with the most important characteristics which should be possessed by lubricants to effectively meet his operating conditions, commensurate with the type of motive power involved.

Air Power

The maintenance of compressed air machinery is directly dependent upon lubrication, inasmuch as the use of any oil in excessive amounts, or a product which may have a tendency to develop high carbon residues, may seriously impair the efficiency of the machine.

In using compressed air as a substitute for steam, it is possible to use either a Diesel or gasoline engine as the prime mover, the air unit being a secondary stage in the power plant. In operation no attempt is made to cool the air. On the contrary, to utilize all the energy available, the air as it leaves the compressor is heated by the exhaust gases from the engine. As a result, on discharge from the compressor this air is at a temperature of approximately 400 degrees Fahr.

How Lubrication Affects Operation

Air compressor oils must be refined to possess characteristics suited to the operating conditions. One must therefore have a clear understanding of the relation between these factors. If all this is realized, the maintenance of compressors and the routine of re-lubrication should be one of the most economical and easy jobs on the entire machine. The essential points to bear in mind when selecting compressor oils are that they should possess adequate viscosity at the operating temperatures and that they show as low a tendency as possible to vaporize and cause accumulation of hard carbon residues.

All petroleum oils, regardless of their base or nature, will be transformed into volatile products and carbon when subjected to enough heat. The extent to which this will occur, however, will depend on the length of time the oil is exposed to such heat. The longer an oil remains within the cylinder, the more carbon can it be expected to develop.

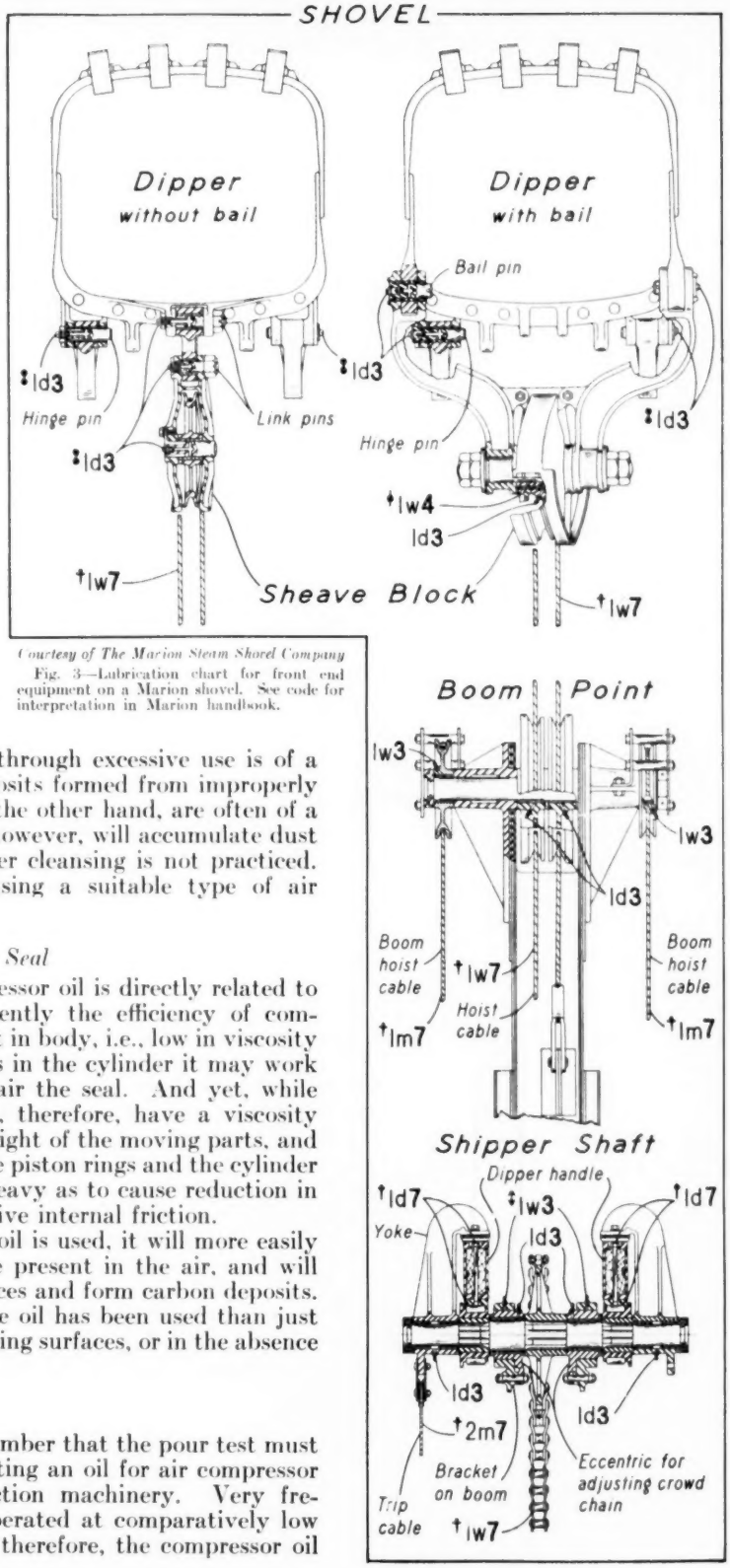
On the other hand, analysis of numerous so-called carbon deposits has proved them to contain quite as much dirt as carbon, the whole being held together by gummy matter from decomposed oil. For this reason an oil having a wide range of distillation, high end point, or too great a viscosity is objectionable, inasmuch as instead of vaporizing cleanly it may break down to become sticky and collect any dirt which is brought in by the air. The slower the breaking down process, or the greater the volume of oil involved, the more carbon will ultimately be developed.

Carbon deposits may be formed in a hard mass, or they may be produced as dust and pass out with the air. In this event it will often

collect in pockets, elbows or on sharp edges to become mixed with dirt taken in by the air as well as with any oil which has been vaporized in the cylinder and later condensed at these points.

Wherever carbon is deposited in the cylinder it may become heated considerably above the temperature of walls due to its low heat conductivity. Not only may this be hazardous, but whenever the residues are hard or sticky they may accumulate on the valves and valve seats, and in the ends of the cylinders. This may cause valves to leak, frequently resulting also in cutting and scoring of both the cylinders and valve seats.

Highly refined straight mineral pale filtered distilled oils show the least tendency towards direct carbonization and the collection of siliceous matter. Furthermore, any carbon that may be formed through excessive use is of a light, fluffy nature. The deposits formed from improperly refined or unsuitable oils, on the other hand, are often of a hard flinty nature. Any oil, however, will accumulate dust if the air is dirty or if proper cleansing is not practiced. Hence the advisability of using a suitable type of air cleaner.



Courtesy of The Marion Steam Shovel Company

Fig. 3—Lubrication chart for front end equipment on a Marion shovel. See code for interpretation in Marion handbook.

Relation of Viscosity to Piston Seal

The viscosity of our compressor oil is directly related to the piston seal and consequently the efficiency of compression. If the oil is too light in body, i.e., low in viscosity at the operating temperatures in the cylinder it may work past the piston rings to impair the seal. And yet, while an air compressor oil should, therefore, have a viscosity high enough to sustain the weight of the moving parts, and form a proper seal between the piston rings and the cylinder walls, it should never be so heavy as to cause reduction in atomization or involve excessive internal friction.

Moreover, if too heavy an oil is used, it will more easily collect any dust that may be present in the air, and will tend to bake on the hot surfaces and form carbon deposits. This is most likely when more oil has been used than just sufficient to lubricate the wearing surfaces, or in the absence of an air cleaner.

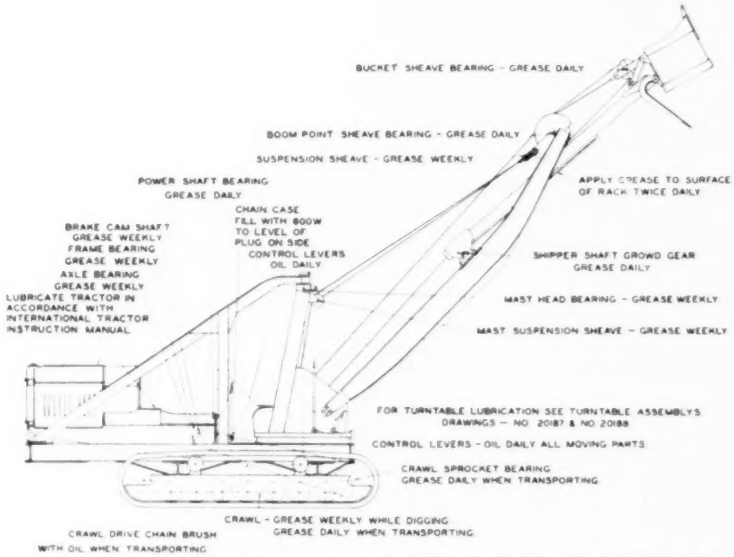
The Pour Test

It is also important to remember that the pour test must be carefully observed in selecting an oil for air compressor service on highway construction machinery. Very frequently power shovels are operated at comparatively low temperatures. It is obvious, therefore, the compressor oil

must be capable of instantaneous flow when the machine is started, otherwise there will be the possibility of abnormal wear on piston rings and cylinder walls. This will, of course, lead to reduction of operating efficiency and loss of power due to leakage.

Swing and Crowd Engines

In the gas-air or Diesel-air machine, the swing and crowd engines are lubricated by a unique type of hydro-static lubricator, built as an integral part of the valve chest cover. With this device the oil feed can be regulated by means of an auxiliary sight feed lubricator. As a result, the delivery of oil can be reduced to the required amount to permit effective lubrication, and yet prevent any possibility of the development of residual deposits in the air lines. In cold weather the oil is kept in a sufficient state of fluidity by means of the heated air in the valve chest.



Courtesy of The Austin-Western Road Machinery Co.

Fig. 4—Showing an Austin-Western badger shovel lubrication diagram.

Internal Combustion Engines

The internal combustion engine power plant offers a decidedly compact and extremely economical arrangement of equipment in certain types of construction machinery. It is important to remember, however, that the internal combustion engine of either the gasoline or Diesel type is of more intricate construction than the average steam engine used for such service. As a result, it requires more care and attention, especially in maintenance and lubrication. Very often break-down in such an engine used to be due to improper lubrication. For this reason the designers have studied lubrication with a view to making it as completely automatic as possible.

The gasoline engine is customarily lubricated by full pressure or a combination of splash and force feed, the oil being handled by a gear pump, driven by the main shaft of the engine. The oil flow is accurately controlled in its intensity, as well as in its starting and stopping by the engine, since the lubricator pumps function in unison with the latter. But while trouble will be averted by proper lubrication, it must not be understood that the efficiency of such an engine is solely dependent upon this item. Other factors, such as the fuel and its manner of combustion, the grade of lubricants used, the extent to which proper cooling is brought about, and the perfection of the design will all, individually or collectively, affect power development. If proper attention is not given to the engine or to the operating conditions, reduction of power and inability of the machine to function satisfactorily may result.

Gasoline Engine Service

The comparatively intensive duty which is involved in the operation of construction machinery imposes extremely exacting requirements upon both the oil and the lubricating system. The most important requirements for an oil for this service are:

(a) As high a degree of lubricating ability as possible.

(b) Heat resisting characteristics.

(c) Dependable seal-forming properties.

(d) Low pour test commensurate with the viscosity to insure ready flow on cold starting, and

(e) Sufficient viscosity to enable the maintenance of an adequate lubricating film with the least amount of internal friction.

Lubricating ability, involves the extent to which an oil will be able to develop and maintain a lubricating film between moving parts. The higher this property, the greater will be the insurance against burnt-out bearings, scored cylinders, or the development of wear.

Heat resisting ability is important as this will be an indication of its resistance to de-

composition and the possible development of extensive carbonaceous residue.

Seal forming ability is a measure of the extent to which the oil will prevent loss of compression, blow-by of combustible gases, or pumping of lubricating oil past the piston rings.

The pour test is of considerable importance, inasmuch as this characteristic will indicate how the oil will act in cold weather. Obviously, the lower the pour test, or the temperature of relative congealment, the more dependable will be the lubricating oil. It must have sufficient fluidity to pass readily through the lubricating system and reach the bearings the instant the engine is started, whatever the temperature.

Viscosity requires consideration from the viewpoint of the extent to which the oil will resist being squeezed out from between any of the wearing parts where pressures may be comparatively high.

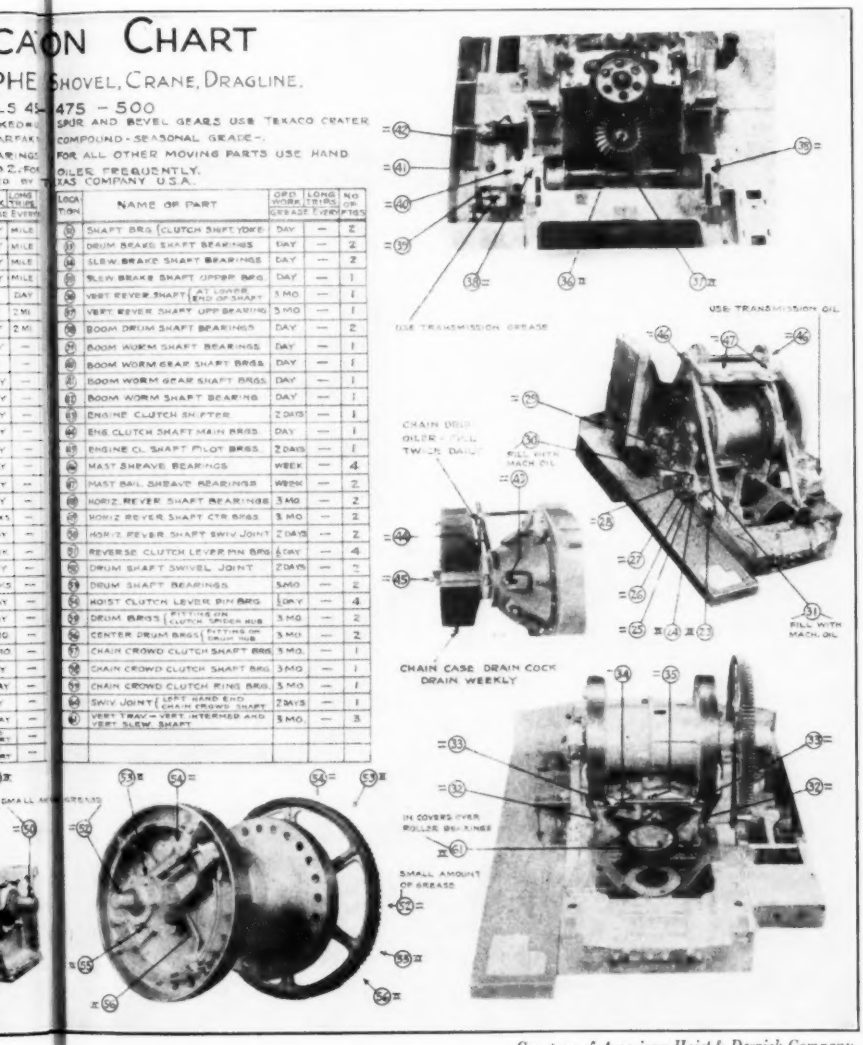
Diesel Engine Drives

Successful lubrication of the Diesel in contracting service will be dependent upon the use of properly refined oil, and the application or delivery of same in sufficient, though never excessive, amounts to the cylinders and bearings by means of a suitably designed oiling system. A Diesel engine lubricating oil must possess certain basic characteristics:

1. It must be so carefully refined as to be able to withstand the usual stresses and strains of intensive service. This requires careful fractionation and effective removal of the lighter components, so that the resultant oil will not be so volatile as to require an undue quantity to maintain a suitable lubricating film, especially on the cylinder walls.
2. It should have as low an emulsification tendency as practicable, due to the chance of contact with water.
3. Furthermore, it must be of such a viscosity or body as to maintain a lubricating film of suitable thickness between the wearing surfaces, under the prevailing temperatures of operation. Yet it should never be so heavy or viscous at these temperatures as to give rise to abnormal internal friction within itself, for this might readily develop excessive operating temperatures, especially on the engine bearings.
4. It should be sufficiently adhesive to resist being squeezed out from between the wearing surfaces when subjected to the normal pressures of operation.
5. It should not congeal, or flow with diffi-

culty, at any of the lower temperatures to which it might be subjected during storage or operation.

6. It should be capable of spreading readily over the surfaces of the cylinder walls,



Courtesy of American Hoist & Derrick Company

not remaining in streaks or blotches, for otherwise suitable sealing of the pistons might be impaired.

7. It must show as little carbon-forming tendency as possible, inasmuch as the decomposition which will occur when the oil is exposed to the intensive heat of combustion will, in the case of many oils, develop a large amount of objectionable carbonaceous residuum. Furthermore, this latter should be easily removed.

Cylinder Lubrication

Proper functioning of the Diesel piston withing its respective cylinder is the basic requirement for maximum power. Cylinder and piston wear are usually the result of impaired lubrication; they will result in loss of compression and reduced power. So we can expect that an engine with badly worn liners may be unable to carry full load. A most effective way by which excessive cylinder wear can be minimized is by use of proper lubricants as well as dependable means of application.

Lubrication of Diesel engine cylinders will also be influenced to a certain extent by the grade of the fuel and the completeness of combustion. If incomplete combustion prevails the piston rings may become stuck by accumulation of non-lubricating, gummy matter. This is another cause for loss in compression. The wrist pins will also be affected. These parts on certain engines will be subjected to relatively high temperatures with but little opportunity for radiation of heat, unless cooled mechanically.

Bearing Lubrication

The Diesel engine bearing should be subjected to comparatively little wear provided these elements are properly aligned, adjusted as to clearance and adequately lubricated. All this is possible since bearings, by virtue of their design and nature of operation, lend themselves to a more effective development of perfect lubrication as a result of more complete separation of the wearing members by a continuous oil film.

Choosing the Lubricating Oil

The Diesel engine, as adapted to present day highway construction machinery, is designed so that its cylinders and bearings can be effectively lubricated by the same oil.

It is particularly advantageous to use an engine of this type and avoid the necessity of

stocking more than one grade of oil for the power plant, for in many localities, the carrying of supplies must be reduced as far as possible.

It is normally customary to use a somewhat heavier oil in warm weather service than under low temperature conditions in order to insure more positive maintenance of piston ring seal and dependable lubrication of the bearings. For temperatures above 20 degrees Fahr., an oil having a viscosity of from 65 to 85 seconds Saybolt at 210 degrees Fahr., will normally be suitable. For temperatures below this dividing line the oil should be somewhat more fluid, of a viscosity range from say 300 to 550 seconds Saybolt at 100 degrees Fahr.

Courtesy of Bucyrus-Erie Company

Fig. 6—The process of grease lubrication by hand pressure gun.

One should always choose an oil which shows a low carbon residue content (by the Conradson Test), and for cold weather service, as low a pour test as possible. A highly refined, straight mineral product can be depended upon to give positive and effective lubrication and reduce the cost of operation to a minimum.

Electric Motors

The use of the electric motor as a secondary drive in some types of contracting and materials handling service requires like consideration in its lubrication. In this regard we must consider the bearings. These must be positively and dependably protected for any failure may lead to the possibility of the rotor coming in contact with the pole pieces, to cause burnouts and shut down of the machine.

The electric motor is, perhaps, the most delicate mechanism involved in materials handling equipment. Frequently, however, it is given no more consideration than the heavy exposed parts which it may drive; although these latter, by virtue of their comparatively heavy construction and the nature of their lubrication, are far more capable of standing the duty imposed by temperature fluctuation, dust, dirt, water, or other contaminating foreign matter. Such conditions will impose a severe strain on electric motor bearings due to their close clearances and the normally limited capacity of their lubricating systems.

Bearing Construction

Power shovel and crane motors are equipped with ring oiled bearings, or with anti-friction bearings of the ball or roller type. Where the ring oiler is employed oil must always be used as the lubricant. Normally, a straight mineral highly refined product of from 200-300 seconds Saybolt at 100 degrees Fahr., will suffice. Such an oil should have adequate fluidity especially where the machine is to be started and operated at sub-normal temperatures.

But little heat will be developed in a well lubricated ring oiled bearing. As a result, every care must be observed in the initial selection of the oil to insure against congealment or sluggish flow when cold; otherwise, damage to the bearings might occur, due to actual lack of lubrication.

Grease Lubricated Bearings

Where anti-friction bearings are involved, either oil or grease may be used as the lubricant, according to the design of the bearing. Oil is preferred where the bearing is capable of retaining the oil supply without leakage. Greases, on the other hand, furnish better seals against the entry of dust, dirt and moisture.

Greases which are to be used for anti-friction bearings must show no tendency to separate in storage or when in action within the bearing. This must hold, likewise, over a considerably wide temperature range.

There should also be no tendency towards

Courtesy of The General Excavator Company

Fig. 7—(left) Showing a view of a General excavator, the relative length of the boom and the span of the wire ropes required.

Courtesy of The Byers Machine Company

Fig. 8—(below) One of the new Byers 85 shovels. This company makes most careful provision for lubrication by coordinating methods of application with the lubricants they consider best, according to the operating conditions.

Courtesy of Lima Locomotive Works, Inc.

Fig. 9—(left) When the shovel is equipped with heavy-duty chains, such service as this requires very careful attention to chain link lubrication.

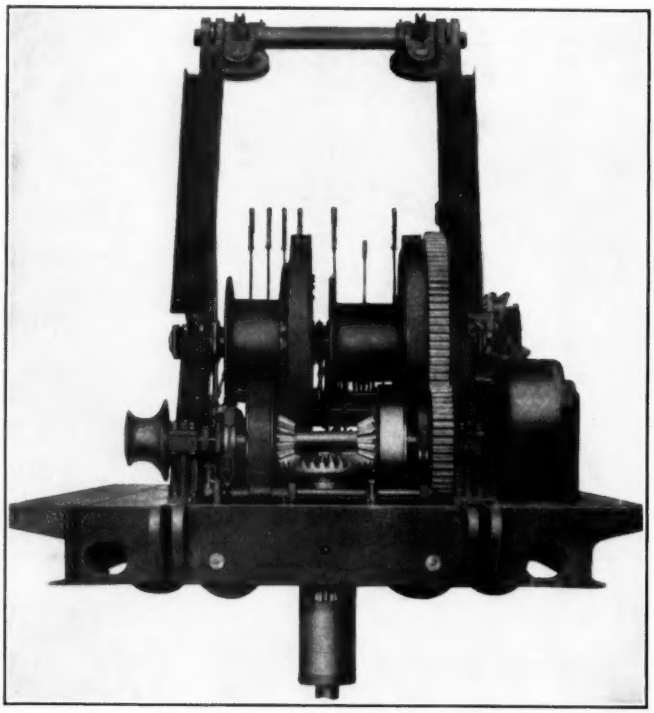
Courtesy of Chain Belt Company

Fig. 10—(above) The Rex 27E concrete paving mixer showing the crawler details and provision for boom and mixer manipulation.

Courtesy of Link-Belt Company

Fig. 11—(left) A type of heavy duty Link-Belt shovel-crawler operation which shows the relative capacity of the digging element.

hardening or decomposition, to develop a residue of soap within the bearing, for it must be remembered that soap has a comparatively low lubricating value; nor should there be any constituent contained in the grease which might lead to corrosion, pitting or rusting of the bearing elements, nor any component which might cause the lubricating film to become sticky or the grease to gum.



Courtesy of The Ohio Locomotive Crane Company

Fig. 12—The operating unit of an Ohio crane showing relative location of the parts.

Grease for such service should be chosen according to consistency, in line with the operating conditions. Frequently a comparatively light product will meet the requirements, especially if it contains an oil of sufficiently low pour test. On the other hand, there are certain grades of heavier grease which, by virtue of their lubricating ability will serve the purpose equally well, and with but a minimum tendency to channel in the housings or retainers.

Steam Cylinders

Steam conditions in power shovel service are the controlling elements in selecting steam cylinder oils. The pressure will usually range around 150 pounds and normally the steam will have quite an extensive moisture content, even though it is taken from the highest part of the boiler. Furthermore, line condensation will be high between the boiler and engines, with a corresponding decrease in pressure, due to the fact that steam pipes are often not covered properly and the engines are frequently subject to intermittent operation.

So there will almost always be an accumulation of water above the throttle valves prior to starting the engines, depending in amount upon the length of time they have been stopped. If the cylinder walls and valve seats are not covered with a tenacious film of properly compounded lubricant, the admission of these slugs of water will tend to wash the lubricant from the wearing surfaces, and for the next few strokes insufficient lubrication will be possible and scoring and abnormal wear may occur.

The constant repetition of this action will soon produce compression losses and inefficient operation of the entire machine, due to steam leakage past the piston rings. Groaning of the engines or rattling of the valves on their seats may also occur in extreme cases.

Cylinder Oil Delivery

So we are quite concerned as to how the oil is delivered to the cylinders. In general, if it is fed into the steam line a few feet above or preceding the throttle valve (unless abnormal conditions arise), atomization can be depended upon to be complete by the time the lubricated steam reaches the throttle valve, and the latter will be quite as effectively lubricated and rendered capable of as efficient operation as the working parts of the engine.

If the point of introduction is located too close to the throttle valve or cylinder, complete atomization may not take place; if too far away there will be a possibility of the oil particles being thrown to the walls of the steam line, from whence a flow of liquid lubricant will occur to the valve chest. This might well be termed condensation of the lubricant; it may be quite considerable if there are any bends or other pipe fittings located between the lubricator and the valve chest.

The Lubricator

To lubricate steam cylinders effectively the oil should be delivered through atomizers and a positive feed lubricator, preferably of the force feed type. Hydrostatic lubricators could be used were the engines to operate continually, but the usual intermittent service involved would either require constant closing and opening by the fireman, or else a waste of oil would follow if the lubricator were left in service while the engines were stopped.

Steam the Actual Lubricator

In other words, the most efficient way of getting the lubricating oil to all desired points is to make use of the steam itself, which reaches all moving elements inside the valve chambers and cylinders.

If the oil is divided into minute globules and intimately mixed with the steam, only a very small quantity is required, and the degree of success in the atomization of the oil will control both the efficiency of lubrication of the parts and the quantity necessary.

Where a crowding engine is located on the boom, the oil line often enters the steam pipe quite a distance back from the throttle, with the result that steam leaks at the ball or swing joint may cause a considerable loss of oil, with subsequent insufficient lubrication.

Character of the Oil

To meet the average requirements effectively it has been determined that steam cylinder oils must be of comparatively heavy body and have a particularly adhesive characteristic in order to insure the maintenance of a lubricating film which will resist the wearing or scraping effects of the average valve and piston, and washing off by the steam itself.

This will be assured by use of an oil which contains a sufficient amount of high grade animal or fixed oil to promote the formation of an extremely tenacious film of emulsified lubricant, which will adequately resist the washing action of any water that may be present. The base of this lubricant should be a medium viscosity, highly adhesive, steam refined cylinder stock.

Viscosity or body is attainable by suitable refining; adhesiveness by judicious treatment of the cylinder stock by the addition of certain fixed or fatty animal oils.

As a general rule, it will be essential to use an oil having a viscosity range of between approximately 100 and 160 seconds Saybolt at 210 degrees Fahr., according to the steam pressure and temperature involved, the type of steam valves and the means of application.

GEAR LUBRICATION

A variety of gears are necessary in the shovel or crane make-up to enable speed reduction and power transmission from the prime mover. There is often a problem involved in the lubrication of certain gears on machines of this type, inasmuch as they are usually exposed, or inadequately housed. There is, therefore, every possibility of dust and dirt gaining entry, to increase the amount of wear and alter the pitch line.

As a general rule the tooth pressures will be comparatively high due to the small areas of contact. The more accurately the gears have been cut the more intense will be the pressure, inasmuch as line contact will more nearly prevail.

Courtesy of Harnischfeger Corporation

Fig. 13—Showing the chain and gear mechanisms on a Harnischfeger shovel. Lubrication of the heavy duty roller chain is of considerable importance in shovel maintenance. It must be carefully handled due to the close clearances which often prevail.

Furthermore, this pressure will be constantly changing, as the gear teeth mesh with each other. This will, of course, change the direction of application of the load. As long as rolling motion predominates, however, the effect on the structure of the teeth will not be serious.

When wear occurs, however, there will be a tendency for the motion between the teeth to become sliding instead of rolling. This will lead to a certain amount of grinding between the teeth, and bring about wear, especially if lubrication is not maintained by means of a gear lubricant which can cushion as well as lubricate.

So our gear lubricant must possess sufficient oiliness to reduce friction to a minimum. This characteristic is dependent upon the viscosity and the ability of the lubricant to adhere to the teeth and resist the pressure which prevails.

Temperature is also a factor. In the normal operation of excavating machinery, gears will function at atmospheric temperature. As a result, the possibility of the gear lubricant being reduced in viscosity by running heat is comparatively remote. It is, in fact, more important to study the effect of low temperature. Under sub-normal temperature conditions, certain types of lubricants will have a tendency

to congeal to such an extent as to become brittle and crack.

Straight mineral lubricants are generally best adapted to the prevailing operating conditions. The average range in viscosity for service on exposed gears will vary from approximately 600 to 1000 seconds Saybolt at 210 degrees Fahr., the higher viscosity being more nearly right to meet the usual requirements.

Where gears are enclosed, however, as is the practice in connection with some types of friction drive machines, the use of chain drives in certain of these installations will require a more fluid lubricant. The average silent chain drive, as employed in this service, will involve comparatively low clearances between the connecting elements which go to make up the links. So the lubricant must be capable of penetrating to all surfaces of contact between these parts; otherwise, here again abnormal wear may take place. To meet this requirement the lubricant should be of about the same viscosity as a heavy steam cylinder oil, i.e., in the neighborhood of 180 seconds Saybolt at 210 degrees Fahr.

WIRE ROPE AND CABLES

Wire rope lubrication is a most important factor in the maintenance of excavating and construction machinery as it is used in practically all hoisting operations and the manipulation of drag scrapers.

The condition of these ropes or cables virtually dictates the output which can be obtained from the machine. In other words, should a rope have one or two broken strands, due to insufficient or improper lubrication, it might very easily lead to a tie-up of the machine should the ends of the strands interfere with the operation of the sheaves.

Strand Friction

One must never assume that because wire ropes come from the manufacturers in a lubricated state, being in general wound on an oil-saturated core, that further lubrication is unnecessary. Under operation there is constant friction and wear between the strands, and a tendency to squeeze out any contained lubricant, especially when the rope passes over sheaves or around drums. The renewal of this product, is, therefore, an absolute necessity.

Strand friction can best be overcome by effective lubrication, brought about by the proper application of a suitably prepared wire rope compound which will be capable of not only penetrating to the innermost strands and core of the rope, but also sufficiently adhesive and viscous to resist being prematurely washed off by rain or sleet or squeezed out by the prevailing pressures between the strands.

In addition to these properties, the lubricant must not tend to cake, gum or ball up, especially if contaminated with an excess of dust, dirt or metallic particles. Furthermore, it must resist the thinning-down effects of higher temperature. This, of course, directly involves the viscosity or relative fluidity of the product. In fact, viscosity in such a product is the essential characteristic involved in purchasing. It should not be assumed, however, as being the chief guide in regard to the actual suitability of a wire rope lubricant.

Here we are more concerned with the ability of the lubricant to function, penetrate and stick under actual operating conditions.

The Viscosity Range

According to the operating temperatures that may be involved, and the possibility of the presence of an excess of water, the viscosity of a wire rope lubricant should range from 500 to 1000 seconds Saybolt at 210 degrees Fahr. Where there might be possibility of such a product thinning down to the extent of dripping off to perhaps result in lack of lubrication, it will be advisable to use a lubricant of approximately 1000 seconds viscosity, of course, in accordance with the prevailing temperatures.

Conversely, under relatively cold conditions, it might be advisable to use a thinner product, but again in accordance with the range of operating temperatures involved.

Wire rope lubricants should, in general, be straight mineral petroleum products, without any fillers or thickening mediums. In other words, whatever the viscosity, it should be an inherent property of the lubricant, not an artificial characteristic which has been built up by compounding.

Application in Service

The average wire rope lubricant must be applied in heated condition; it will usually be too heavy or viscous to permit of daubing or painting on the rope surface. Even though the latter might be more or less coated, the possibility of penetration occurring to any extent would be remote.

SUMMARY

And so we have presented the various requirements of excavating and contracting machinery lubrication. To be sure we have had to be brief in parts, but if our remarks serve as a reminder to the operator to consider lubrication as the assistant to lower maintenance costs, our discussion will be justified.

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TEXACO ON HIGHWAY AND CONTRACTING MACHINERY

THE POWER PLANT

STEAM CYLINDERS

Saturated Steam (above 150 lbs.) . .	TEXACO CAVIS CYLINDER OIL or TEXACO LEADER CYLINDER OIL
Saturated Steam (below 150 lbs.) . .	TEXACO PINNACLE CYLINDER OIL or TEXACO DRACO CYLINDER OIL

THE DIESEL

(According to operating conditions, engine requirements, and manufacturers' recommendations)	TEXACO ALGOL or TEXACO URSA OILS

GASOLINE ENGINES

(According to manufacturers' recommendations)	TEXACO MOTOR OILS

AIR COMPRESSORS

Cylinder	HAVOLINE or TEXACO MOTOR OIL S.A.E. 10 or 20 or TEXACO CETUS or ALCAID OIL
External Parts	TEXACO ALEPH or ALTAIR OIL

BEARINGS

Plain Bearings (oil lubricated) . . .	HAVOLINE or TEXACO MOTOR OIL S.A.E. 20 or 30 or TEXACO ALEPH or ALTAIR OIL
Plain Bearings (grease lubricated) .	TEXACO CUP GREASES or TEXACO MARFAKS
Roller Bearings	TEXACO MARFAKS or TEXACO STARFAK GREASE No. 2
Chassis Parts	TEXACO MARFAKS or TEXACO CHASSIS LUBRICANTS

GEARS and CHAINS

Transmissions and Differentials . .	TEXACO THUBANS (to conform with operating temperatures)
Exposed or Semi-enclosed Elements	TEXACO CRATER COMPOUNDS (of a grade commensurate with type of housing and operating temperature)

WIRE ROPE: **Use Texaco Crater Compounds for strand protection and core preservation in service. The grade to be commensurate with operating conditions and means available for application. See "Lubrication," February, 1936.**

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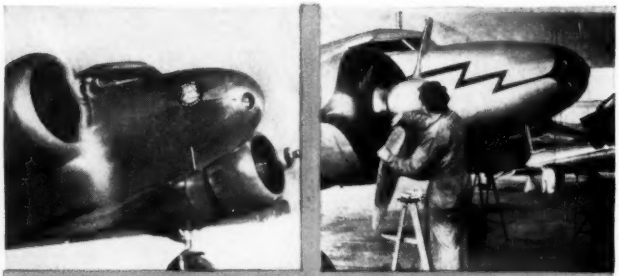

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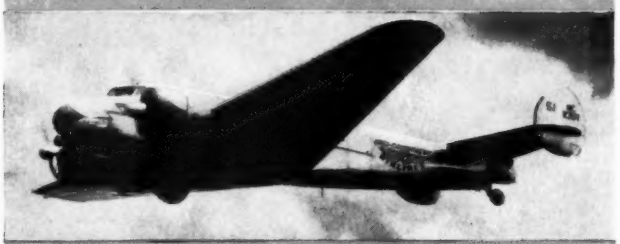

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